

# Antibiotic Resistance in Sustainable Solid Waste Management Systems: Quantitative Evidence, Molecular Insights and Process-Level Control Strategies

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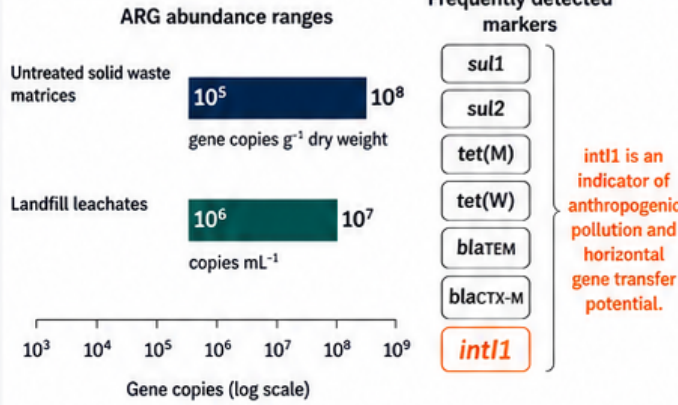
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## 1. BACKGROUND

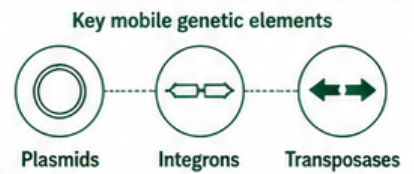
- Antibiotic resistance (AR) is an environmental and engineering challenge.
- Solid waste management systems are important reservoirs and transmission pathways for antibiotic-resistant bacteria (ARB) and antibiotic resistance genes (ARGs).
- Municipal, healthcare, and organic solid waste streams can all contribute to environmental dissemination.

## 2. EVIDENCE BASE AND MOLECULAR MARKERS

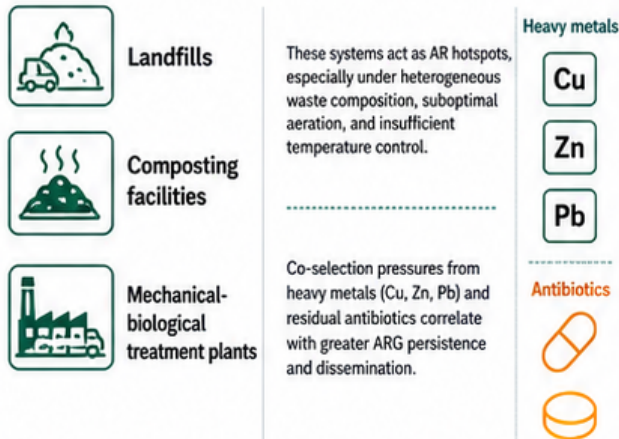


## 3. METAGENOMIC INSIGHTS

- Metagenomic profiling reveals a diverse resistome.
- Multidrug resistance mechanisms are commonly dominant.
- Clinically relevant resistance classes often co-occur with mobile genetic elements.



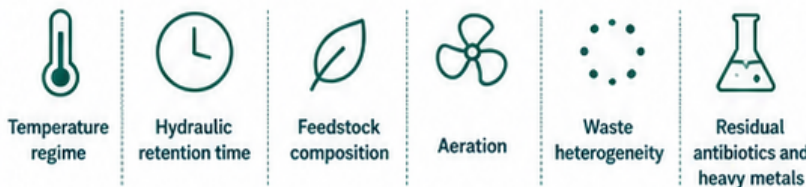
## 4. ENGINEERING HOTSPOTS



## 5. COMPARATIVE PERFORMANCE OF TREATMENT TECHNOLOGIES

| Treatment technology                      | Performance on ARB/ARGs  | Effectiveness      |
|---|--|--------------------|
| Incineration / high-temperature pyrolysis | Near-complete elimination of ARB and ARGs.   | ★★★★★<br>EXCELLENT |
| Anaerobic digestion                       | Variable performance, typically 1–3 log reduction.   | ★★★<br>MODERATE    |
| Thermophilic digestion (>55 °C)           | Consistently outperforms mesophilic systems.   | ★★★★★<br>GOOD      |
| Conventional composting                   | Often incomplete removal or transient enrichment unless sustained thermophilic conditions and extended maturation are applied. | ★★<br>POOR         |

## 6. KEY PROCESS DRIVERS



## 7. MAIN TAKE-HOME MESSAGES

- Solid waste systems are both a source and a control point for environmental AR.
- Molecular monitoring tools such as qPCR and metagenomics are essential.
- Process optimization and risk-based engineering design can reduce dissemination.
- Sustainable waste management must integrate public health protection within circular economy frameworks.

## 8. CONTROL STRATEGY FLOW DIAGRAM



## 9. ACKNOWLEDGEMENTS

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